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Abstracts

Gas chromatographic analysis of alliin in the callus tissues of *Allium sativum*, T. HAYASHI, K. SANO, and C. OHSUMI: *Biosci. Biotech. Biochem.*, **57**, 16662–16663 (1993).

Gas chromatographic analysis of sulfur amino acids was used for the trimethylation of sulfur amino acids. The trimethylsilylation was tested with 1mg of alliin in a vial and serine as an internal standard. In the cultured tissues of *A. sativum*, alliin was formed only in the shoot-forming callus, which could be detected by both FID and FPD.

Interspecific hybrid between *Allium cepa* and *Allium sativum*, C. OHSUMI, A. KOJIMA, K. HINATA, T. ETOH and T. HAYASHI: *Theor. Appl. Genet.*, **85**, 969–975 (1993).

Interspecific hybrids between *Allium cepa* and *Allium sativum* were obtained using the fertile clone *A. sativum* as the male parent. The nascent embryos which formed shortly in interspecific hybridization between *A. cepa* and *A. sativum* were rescued by ovule culture at an early stage. The zygotes or proembryos developed in Murashige and Skoog medium containing 5.7×10^{-8} M indole-3-butyric acid (IBA). Once developed, the embryos were taken out of the ovule and cultured on embryo culture medium where they regenerated into whole plants. The hybridity of the plants obtained was examined by morphological observation, chromosome analysis, and ribosomal RNA gene analysis. The analyses proved that the plants were mature sexual hybrids between *A. cepa* and *A. sativum*. Each hybrid plant had keeled but fistulose leaves and formed a bulb resembling that of *A. cepa*. The hybrids produced not only *S*-propenyl-L-cysteine sulfoxide, which is the major flavor precursor in *A. cepa*, but also *S*-allyl-L-cysteine sulfoxide (alliin), which is characteristic of *A. sativum*.

Formation of alliin in the culture tissues of *Allium sativum*. Oxidation of *S*-allyl-L-cysteine, C. OHSUMI, T. HAYASHI and K. SANO: *Phytochemistry*, **33**, 107–111 (1993).

Addition of *S*-allyl-L-cysteine markedly increased the level of alliin in both shoot-forming and root-forming callus tissue of *A. sativum*. The oxidation of *S*-allyl-L-cysteine to alliin was examined using *S*-allyl-L- $[^{35}\text{S}]$ cysteine and *S*-allyl-L- $[^{14}\text{C}]$ cysteine and subsequent analyses of enzymatic degradation and of the isomer formation of the product. The sulfoxide of *S*-allyl-L-cysteine was confirmed to be (+) *S*-allyl-L-cysteine sulfoxide. No (–) *S*-allyl-L-cysteine sulfoxide was formed in the cells. These findings suggested the presence of specific oxidase in the cells. The *S*-allyl-L-cysteine added to the culture was quantitatively converted into alliin in this tissue during culture.

The primary wall controls plant cell growth, T. HAYASHI: *Protein Nucleic Acid and Enzyme*, **37**, 2968–2976 (1992) (in Japanese).

The review focuses on the function of the primary wall in higher plants.

Abstract

Cell wall engineering on growing plants, T. HAYASHI: *Wood Research and Technical Notes*, **28**, 1–10 (1992) (in Japanese).

The review focuses on cell wall engineering in higher plants.

Cell biological studies on the surface carbohydrate of plant cell, T. HAYASHI: *Nippon Nogeikagaku Kaishi*, **67**, 7–13 (1993) (in Japanese).

The review focuses on the surface carbohydrate of plant cell and function of the primary wall in higher plants.

Oligosaccharide signals in higher plants. Biological activities in fragments, T. HAYASHI: *Chemical Regulation of Plants*, **28**, 33–40 (1993) (in Japanese).

The review focuses on the biological activities in fragment oligosaccharides in higher plants.

Biotechnology in Pulp the Paper Industry : Proceedings of the fifth international conference on biotechnology in pulp and paper industry, M. KUWAHARA and M. SHIMADA (Eds.): Uni Publishers Co., Ltd., p. 1–544 (1992).

Current topics of biotechnology in pulp and paper industry were included, dealing with microbial and enzymatic applications in pulping, microbial and enzymatic conversion of wood and its related components, and genetics of lignocellulose-degrading fungi an woody plants.

New biochemical aspects of oxalic acid production and decomposition by wood-destroying fungi, M. SHIMADA, Y. AKAMATSU, D.B. MA and M. TAKAHASHI: *Biotechnology in Pulp and Paper Industry* (Eds. M. Kuwahara and M. Shimada), p. 273–278 (1992).

On the basis of our first reports on the hydrolytic degradation of cellulose by 1% oxalic acid solution and the inhibition of lignin peroxidase (Lip) by this acid, we have proposed here a new hypothesis to explain a role of oxalic acid metabolism involved in brown-rot and white-rot decay processes.

A novel equation for the noncompetitive inhibition of the LiP catalyzed reactions by oxalic acid, D.B. MA, T. HATTORI, Y. AKAMATSU, M. ADACHI and M. SHIMADA: *Biotechnology in Pulp and Paper Industry* (Eds. M Kuwahara and M. Shimada), p. 321–326 (1992).

The secondary metabolite of veratrylglycerol (VG) underwent a $C\alpha-C\beta$ bond cleavage catalyzed by an electrophoretically homogeneous Lip isozyme of *P. chrysosporium*, forming the products of veratraldehyde and glycolaldehyde. The reaction was inhibited potently by oxalic acid (OX), with concomitant decomposition of OX to CO_2 . The Dixon plots obtained at different concentrations of VG show that the inhibition is noncompetitive for the

substrate ($K_{iapp}=1.13$ mM). Similarly, the addition of OX also inhibited the Lip-catalyzed oxidations of other nonphenolic substrates and DHP (dehydrogenated polymer), but did not significantly inhibit the oxidations of phenolic substrates. Further investigations showed that it is oxalate ($^-OOC-COO^-$), but not mono oxalate anion ($HOOC-COO^-$) or oxalic acid ($HOOC-COOH$), which inhibited the Lip-catalyzed oxidations by reducing the cation radical intermediate back to the substrate level. Accordingly, the mechanism is proposed for the inhibition of the Lip-catalyzed C α -C β bond cleavage of VG by OX. Furthermore a novel equation has been derived to explain the mechanism for the unique noncompetitive inhibition of the Lip-catalyzed oxidations, which is distinguished from the classical noncompetitive inhibitions in which allosteric inhibitors are involved.

Influences of various factors on oxaloacetase activity of the brown-rot fungus *Tyromyces palustris*, Y. AKAMATSU, M. TAKAHASHI and M. SHIMADA: *Mokuzai Gakkaishi*, Vol. 39, 352–356 (1993).

Some characteristics of an oxaloacetase system in cell-free extracts of the wood-rotting basidiomycete *Tyromyces palustris* (Berk. and Curt.) Murr. were investigated. The optimal pH was found to be about neutral. The optimum temperature was 40°C. The enzyme activity was enhanced about three-fold by the addition of 1 mM Mn^{2+} into the reaction mixture. The keto-acids such as α -ketoglutaric, α -ketobutyric, and pyruvic acids did not serve as a substrate. The K_m value for oxaloacetic acid was found to be 0.83 mM. The enzyme activity was the greatest on Day 3 of the cultivation, and it decreased thereafter. The increase in the amounts of oxalic acid in the culture medium was not parallel to the enzyme activity but still continued until Day 10. The result suggests that the enzyme plays an important role in the production of oxalic acid in the early step of cultivation.

Formate and oxalate ester structures in antiviral water-soluble lignin from bagasse degraded by *Lentinus edodes*, T. HATTORI, J. KAJIHARA, H. SHIRONO, Y. YAMAMOTO and M. SHIMADA: FEMS Symp. on Lignin Biodegradation and Transformation (Eds., J.C. Duarte, M.C. Ferreira and P. Ander), p. 31–34 (1993).

We report here that the alkaline hydrolysis of WSLC gave formic and oxalic acids. Since the alkaline hydrolysis of MWL did not give the two acids, it is suggested that WSLC contains formate and oxalate structures produced by aromatic ring opening reaction by *Lentinus edodes*.

A possible regulatory role of oxalic acid in lignin degradation by *Phanerochaete chrysosporium*, M. SHIMADA, Y. AKAMATSU, D.B. MA and T. HATTORI: FEMS Symp. On Lignin Biodegradation and Transformation (Eds., J.C. Duarte, M.C. Ferreira and P. Ander), p. 111–114 (1993).

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A possible regulatory role of oxalic acid in lignin biodegradation was described. A key role of oxalate pathway in conjunction with both TCA cycle and lignin and wood polysaccharide metabolism were also described.

A novel glyoxylate oxidase of the brown-rot fungus *Tyromyces palustris*, Y. AKAMATSU and M. SHIMADA : FEMS Symp. on Lignin Biodegradation and Transformation (Eds., J.C. Duarte, M.C. Ferreira and P. Ander), p. 149–150 (1993).

Biosynthetic pathway for production of oxalic acid was investigated. A novel type of glyoxylate oxidase was first extracted from the brown-rot fungus *Tyromyces palustris*. This enzyme activity was detected also in the white-rot fungi such as *Trametes versicolor* and *Phanerochaete chrysosporium*.

Studies on the mechanism of lignin-degrading peroxidase formation by the white-rot fungus *Phanerochaete chrysosporium*, D.B. MA, P.J. GAO, Z.N. WANG and M. SHIMADA : FEMS Symp. On Lignin Biodegradation and Transformation (Eds., J.C. Duarte, M.C. Ferreira and P. Ander), p. 169 (1993).

The effects of PU (polyurethane foam) cubes and MnSO_4 on the LiP production by the white-rot fungus *Phanerochaete chrysosporium* were investigated in shaking culture. Under the shaking culture conditions, the LiP activity was greatly enhanced up to 950 U/liter medium by adding both the PU cubes (6 cubes/200 ml flask) and MnSO_4 (180 μM). Under the same culture conditions we also obtained good MnP productions (1,000–1,400 U/liter medium). The effects of oxygen, Tween 80, veratryl alcohol, and MnSO_4 on the biosyntheses of both LiP and MnP were also investigated in shallow stationary and shaking cultures. In both the cultures similar results were obtained. The cultures flushed with 100% O_2 gave higher activities of LiP and MnP than the control ones at the early stage of the enzymes syntheses, but did not give good production of the enzymes ultimately. As usually reported Tween 80 significantly enhanced the activities of the two enzymes. The biosyntheses of LiP and MnP absolutely depended on the presence of or were induced by veratryl alcohol and MnSO_4 , respectively. In the presence of veratryl alcohol LiP activity was improved by adding MnSO_4 , and similarly in the presence of MnSO_4 the activity of MnP was also enhanced by addition of veratryl alcohol, showing cross inductions of the biosyntheses of LiP and MnP by the two inducers. Based on the above results we propose that some of the LiP genes and some of the MnP genes might be clustered together in the genome of the white-rot fungus *P. chrysosporium*. The biosyntheses of all the LiP isozymes and all the MnP isozymes are controlled by the inductions of veratryl alcohol and Mn^{2+} , respectively, while the isozymes (of LiP and MnP) encoded by the clustered genes can only be produced in the presence of both veratryl alcohol and Mn^{2+} .

The effect of oxalic acid on the manganese-dependent peroxidase-catalyzed oxidations, D.B. MA, T. HATTORI, Y. AKAMATSU, M. ADACHI and M. SHIMADA: Proceedings of the 7th International Symp. On Wood and Pulp Chemistry, Vol. II, p. 644-649 (1993).

The oxidation of MnII (Mn^{2+}) to MnIII (Mn^{3+}) catalyzed by Manganese-dependent-peroxidase (MnP) was inhibited by oxalic acid (OX), which reduced the MnIII back to MnII with concomitant decomposition of the acid to CO_2 . The $1/v$ versus [OX] plots obtained in the presence of different fixed concentrations of MnII at low concentrations (0.00–0.80 mM) of OX assumed noncompetitive inhibition type of Dixon plots. The steady-state kinetics of the inhibition was analyzed ($K_{iapp}=1.33$ mM). The phenolic lignin model compound syringaldazine also inhibited the MnP-catalyzed oxidation of MnII to MnIII in a similar manner ($K_1=20$ μM). At high concentrations OX inhibited the MnP/ H_2O_2 /MnII-catalyzed oxidations of the phenolic lignin model compounds of guaiacol and syringaldazine by competing for the MnIII formed by the MnP/ H_2O_2 /MnII system with the phenolic compounds.

Chiral HPLC and LC-MS Analysis of Several Lignants, T. UMEZAWA, T. ISOHATA, H. KURODA, T. HIGUCHI and M. SHIMADA: In "Biotechnology in Pulp and Paper Industry" (M. Kuwahara and M. Shimada, eds.), Uni Publishers, Tokyo, pp. 507–512 (1992).

Six lignans were isolated from *Forsythia koreana* and their racemic modifications were chemically synthesized. Enantiomers of the synthesized lignans were separated by chiral HPLC. FRIT-FAB mass spectra of the lignans were obtained by coupling the chiral HPLC directly with mass spectrometer. The chiral LC-MS system was successfully applied to the assay of enzyme activity for enantioselective formation of (–)-secoisolariciresinol. Cell-free extracts of *F. koreana* catalyzed formation of (–)-[$^2\text{H}_{10}$]secoisolariciresinol, but not of (+)-enantiomer, from [9,9- $^2\text{H}_2$, OC $^2\text{H}_3$]coniferly alcohol.

Purification and partial sequences of *Aralia cordata* cinnamyl alcohol dehydrogenase, T. HIBINO, D. SHIBATA, T. UMEZAWA and T. HIGUCHI: *Phytochemistry*, **32**, 565–567 (1993).

Cinnamyl alcohol dehydrogenase (CAD) (EC 1.1.1.195) from a dicot, *Aralia cordata*, was purified to homogeneity and its properties were characterized. The enzyme shows a preference for cinnamyl alcohols and cinnamyl aldehydes as substrates. The M_r is estimated at 72,000. The enzyme is composed of two heterogeneous subunits of slightly different sizes, and it differs from the bean enzyme in the size of subunits. Partial amino acid sequencing of the purified enzyme was carried out both from the *N*-terminus and using selected peptides obtained by cyanogen bromide cleavage.

Mechanisms for biochemical and genetic control in lignin and lignan biosyntheses, M. SHIMADA: Abstracts of Research Project, Grant-in-Aid for Scientific Research (A), pp. 1–103 (1993).

Mechanisms for biochemical and genetic control in lignin and lignan biosyntheses were reviewed.

Molecular architecture of poplar cell wall by quick freeze, deep etch technique, T. ITOH and T. OGAWA: Plant Cell Wall as Biopolymers with Physiological Functions, Yamada Science Foundation, Osaka, 173–178 (1992).

Molecular architecture of the cell wall of poplar suspension cultured cells was investigated by rapid-freezing and deep-etching techniques. The cross-bridges between cellulose microfibrils were observed. The gradual chemical extraction of the cell wall showed that pectin and hemicellulose was extracted, resulting in the removal of cross-bridges.

The formation of plant cell wall and low temperature electron microscopy, T. ITOH: *Electron microscope*, **27**, 76–82 (1992) (in Japanese).

The increasing importance of low temperature electron microscopy for the studies on the formation of plant cell walls was briefly described. Freeze substitution, freeze fracture and deep etching electron microscopy were reviewed based on the practical uses of the techniques.

Wooden remains excavated from the bottom of Lake Biwa, so called Awazu-Kotei relics, T. ITOH: No. 6, Shigaken-Bunkazai-hogo-Kyoukai, 1–14 (1993).

Awazu-kotei relics is located in the southern part of Lake Biwa. It is the relics that had been prosperous in middle of Jomon period. The following species has been identified microscopically; *Torreya* spp., *Abies* spp., *Pinus* spp. (*Diploxylon*), *Cryptomeria japonica*, *Quercus* spp. Sect. *Prinus*, *Castanea* spp., *Quercus* spp., *Alnus* spp. Twenty nine among 100 samples were identified as *Quercus* spp. Sect. *Prinus*.

Fossile wood of the petrified forest around the Echi River, Shiga Prefecture, T. ITOH: Research Report of the Lake Biwa museum Project Office, No. 1, 33–45 (1993).

Fossil wood was excavated from the stream bed of Echi River located in Shiga prefecture. The fossil wood has passed more than 200 million years. Fifty three among ca. 130 fossil wood were identified; that is, 26 of Taxodiaceae, 6 of conifer, 15 of *Alnus* spp., 2 of Rosaceae (?), one of *Fraxinus* spp., 2 of diffuse-porous species, one of ring-porous species (?).

Arrangement of cortical microtubules in elongating epicotyl of *Aesculus turvinate* Blume, K.D. KANG, T. ITOH and W.Y. SOH: *Holzforschung*, **47**, 9–18 (1993).

In order to elucidate the arrangement of microtubules (MTs) during the organ

elongation, we examined the arrangements of cortical MTs in the elongating epicotyl of *Aesculus turbinata* by immunofluorescence microscopy using cryosections. Under both dark and light-dark growth conditions, the arrangement of MTs was associated with the rates of elongation and differed according to the region in the same epicotyl. In the component cells of epicotyl grown in dark, the arrangement of MTs was exclusively transverse in the potential active elongating region (A), relatively transverse in the active elongating region (B) and predominantly oblique in the less-elongating region (C) and in the non-elongating region (D). During the growth of epicotyl, the arrangement of MTs in the component cells was gradually altered from transverse to oblique or longitudinal direction. In light-dark grown epicotyl, the change in MT arrangement of the component cells occurs somewhat earlier than that of dark condition and shows a rather gradual process. That is, the arrangement of MTs was predominantly transverse in region A, predominantly oblique in region B, and relatively oblique and/or longitudinal in regions C and D. These results indicate that the change in arrangement of cortical MTs from transverse to oblique or longitudinal ones occurs in the cortex before elongation stops. Orientation of MTs in both growth conditions seems to be steeper in the outer than in the inner parenchyma cells and to change earlier in the light-dark grown epicotyl.

Immunocytochemistry on the cell wall polysaccharides in the woody plants, K. BABA, Y. SONE, A. MISAKI, N. SHIBUYA, T. HAYASHI and T. ITOH: Plant Cell Walls as Biopolymers with Physiological Functions, Yamada Science Foundation, Osaka, 327–331 (1992).

Xyloglucan and glucomannan was localized in the differentiating xylem cells of pine, poplar and bamboo using immuno-gold electron microscopy. Xyloglucan was observed in primary wall of all the species. Glucomannan was observed in the secondary wall of pine.

Immunoelectron microscopic analysis of tissue and variety specific accumulation of glucomannan in rice seed cell walls using mannoooligosacchride-specific antibody, H. KAKU, K. BABA, T. ITOH and N. SHIBUYA: Plant Cell Walls as Biopolymers with Physiological Functions, Yamada Science Foundation, Osaka, 431–433 (1992).

Glucomannan localization in the seed of rice was observed by immuno-gold electron microscopy. Glucomannan was localized in the endosperm cell wall, but not in aleuron cell wall.

Delignification and Production of Ligninolytic Enzymes by Edible Mushrooms, M. KUWAHARA, H. KOFUJITA, Y. ASADA, T. WATANABE and J.-Y. ZHOU: Proceedings of 7th International Symposium on Wood and Pulp Chemistry, Vol. 2, p. 709–713 (1993).

During the course of delignification of wood meal, white-rot fungi *Phanerochaete*

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chrysosporium, *Lentinus edodes* and *Pleurotus ostreatus* produced Mn(II)-peroxidase. However, lignin peroxidase activity was not detected in this culture condition. In the liquid cultures of *L. edodes* and *P. ostreatus*, lignin peroxidase activity was not found. In a glucose-peptone medium, *P. ostreatus* produced Mn(II)-peroxidase as a mixture of at least two isozymes and these protein were purified and characterized. Laccase activity was found both in the liquid and wood-meal cultures of *L. edodes* and *P. ostreatus*. Laccase produced in the wheat-bran culture by *L. edodes* was purified and characterized. Mn(II)-peroxidase and laccase activities were also detected in the liquid cultures of *Coriolus* species and other strains of basidiomycetes.

Production of phenol oxidizing enzymes in wood-meal medium by white rot fungi, H. KOFUJITA, A. MATUSHITA, T. OSAKI, Y. ASADA and K. KUWAHARA : *Mokuzai Gakkaishi*, **38**, 950–955 (1992).

Properties phenol oxidizing enzymes secreted into wood-meal medium by three white-rot basidiomycetes, *Phanerochaete chrysosporium*, *Lentinus edodes* and *Pleurotus ostreatus*, were investigated. The composition of phenol oxidizing enzymes produced on wood-meal culture was different from those on liquid culture. On the wood-meal cultures of these fungi, Mn(II)-peroxidase activity was much higher than laccase and lignin peroxidase in wood materials. Using an ion exchange chromatography, the presence of multiple Mn(II)-peroxidase in the wood-meal culture of *P. chrysosporium* was confirmed, while the dominant isoenzyme produced was different from that in the liquid culture.

Production of lipids containing n-6 series poly-unsaturated fatty acids in microorganisms, S. ISHIDA and M. KUWAHARA : *Memoris of Shiga Women's Junior College*, No. 18, 1–8 (1993) (in Japanese).

It was found that production of lipid containing two highly unsaturated fatty acids, γ -linolenic and arachidonic acids, as main components, was found to be promising by the cultivation of a fungus, *Conidioborus ovscurus*. By 5-days culture of this fungus, lipid containing 9.5% γ -linolenic acid and 9.5% arachidonic acid was obtained.

Characterization of a cDNA and gene encoding a lignin peroxidase, from the lignin-degrading basidiomycete, Bjerkandera adusta, Y. ASADA, Y. KIMURA, T. OKA and M. KUWAHARA : "Biotechnology in Pulp and Paper Industry", ed. M. Kuwahara and M. Shimada, Uni Publishers, Tokyo, p. 421–426 (1992).

A cDNA and a genomic DNA encoding a lignin peroxidase from the lignin-degrading basidiomycete, *Bjerkandera adusta* were isolated and characterized. The cDNA clone, λ LPO-1, and genomic clone, pLPO-1, were identified in the cDNA and genomic DNA libraries, respectively, by hybridization screening using a deoxyoligonucleotide probe which corresponds to the N-terminal amino acid sequence of the purified enzyme (main isozyme,

LPO-2). The nucleotide sequence of λ LPO-1 predicts a mature protein containing 349 amino acid residues with a molecular weight of 37,225 preceded by a signal peptide of 23 amino acid residues. Comparison of the sequences of λ LPO-1 and pLPO-1 reveals that the protein-encoding sequence of the structural gene is interrupted by four small introns which conform to the universal G-T/A-G splicing rule observed for the 3' and 5' intron boundaries. The putative eukaryotic regulatory sequences, i.e. "CAAT" and "TATA" box-like sequences, are present in the 5' flanking region of the gene.

Biomass conversion of glycans from wood, T. WATANABE: *Wood Research and Technical Notes*, **28**, 11–32 (1992) (in Japanese).

Recent technology on biomass conversion of wood polysaccharides was reviewed.

Purification and properties of *Aspergillus niger* β -glucosidase, T. WATANABE, T. SATO, S. YOSHIOKA, T. KOSHIIJIMA and M. KUWAHARA: *Eur. J. Biochem.*, **209**, 651–659 (1992).

β -Glucosidase was purified from a crude cellulase preparation from *Aspergillus niger* by affinity chromatography. The purified enzyme was dimer with an isoelectric point of 4.0. The molecular mass of the enzyme was estimated to be 240 kDa by gel permeation chromatography. The enzyme hydrolyzed specifically β -glucosidic bonds and catalyzed transglycosylation. Temperature and pH optimum for the hydrolysis was pH 4.5 and 55°C, respectively. K_m values for p-nitrophenyl β -glucoside and cellobiosaccharides were also determined.

Quantitative analysis of ester bonds between lignin and glucuronoxylan in lignin-carbohydrate complexes, T. WATANABE, T. IMAMURA, T. KOSHIIJIMA and M. KUWAHARA: *Biotechnology in Pulp and Paper Industry*, ed. by M. Kuwahara and M. Shimada, Uni Publishers, Tokyo, pp. 279–283 (1992).

Ester linkages between lignin and glucuronic acid residue of glucuronoxylan in *Fagus crenata* wood were determined by using oxidative cleavage of the ester bonds with 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ) in the presence of trifluoroacetic acid (TFA). Based on the acid conjugated DDQ-oxidation of water-soluble lignin-carbohydrate complexes (LCC-WE) from the hard wood, frequency of the ester bonds between the lignin and glucuronic acid residue of glucuronoxylan was determined to be 1.6 per molecule of LCC-WE.

Transglycosylation of β -glucosidase purified from *Aspergillus niger*, T. WATANABE, T. KOSHIIJIMA and M. KUWAHARA: *Biotechnology in Pulp and Paper Industry*, ed. by M. Kuwahara and M. Shimada, Uni Publishers, Tokyo, pp. 407–412 (1992).

β -Glucosidase purified from *Aspergillus niger* catalyzed transglycosylation of β -glucosyl residue. When the β -glucosidase was reacted with cellobiose in aqueous organic solvents

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containing acetonitrile, methyl alcohol, ethyl alcohol, dimethylsulfoxide or N,N-dimethylformamide, formation of trisaccharides was observed under all of the reaction conditions examined. Among the reaction media, aqueous acetonitrile was the most effective for the transglycosylation. The maximum yield of the trisaccharide was 55.7% based on the consumed cellobiose. NMR and methylation analysis of the transglycosylation products indicated that the β -glucosyl transfer occurred preferentially at the primary position of the acceptor molecule. However, glucosyl transfer to C-3 and C-4 positions of non-reducing end of the cellobiose was also observed.

Affinity chromatography of glycosidases on crosslinked methacrylamide copolymer bearing glycamine, T. WATANABE and M. KUWAHARA : *Mokuzai Gakkaishi*, **39**, 368–373 (1993) (in Japanese with English summary).

A new biospecific adsorbent for the purification of glycosidases was studied using glycamine and four different epoxy-activated carriers. As a result, a crosslinked methacrylamide-N-methylene-bis-methacrylamide copolymer bearing glycamine was found to be effective for the purification of glycosidases.

Mutational analysis of the specific priming signal essential for DNA replication of the broad host-range plasmid RSF1010, Y. HONDA, T. AKIOKA, S. TAKEBE, K. TANAKA, D. MIAO, A. HIGASHI, T. NAKAMURA, Y. TAGUCHI, H. SAKAI, T. KOMANO and M. BAGDASARIAN : *FEBS letters*, **324**, 67–70 (1993).

To analyze the RSF1010-specific priming mechanism, a library of randomly mutagenized *ssiA* sequences was constructed by chemical synthesis using mixed nucleotide phosphoramidites. Synthetic *ssiA* sequences with the single base substitutions were assayed for the SSI activity in *E. coli* JM109 expressing RepB' primase. It was demonstrated that the activity of *ssiA* was damaged markedly by single base-substitutions within the possible stem-loop structure and its 3'-flanking region. It is conceivable that these domains are critical in recognition and primer synthesis by the RSF1010-encoded specific primase, RepB'.

Dynamic mechanical properties of chemically modified wood, H. AKITSU, J. GRIL, T. MOROOKA and M. NORIMOTO : FRI (New Zealand) Bulletin, No. 176, 130–139 (1992).

The influence of chemical modification on acoustical properties of wood was analyzed using rheological analogies. After elimination of the swelling contribution to the expressions of longitudinal dynamic specific modulus (E'/γ) and internal friction ($\tan \delta$), the modification of matrix molecular mobility could be quantified.

Permanent fixation of compressive deformation of wood, Mechanisms of permanent fixation, M. INOUE, T. MOROOKA, M. NORIMOTO, R.M. ROWELL and G. EGAWA : FRI (New Zealand) Bulletin, No. 176, 181–189 (1992).

We attended to permanently fix the compressive deformation of wood by three methods. The first method is to make wood inaccessible to water by introducing hydrophobic substituent such as acetyl groups. Recovery of compressive deformation of the acetylated wood by wetting decreased at room temperature as the acetyl content increased, although almost perfect recovery occurred by boiling in water or soaking in acetone. The second method is to form crosslinking between wood components as in the formalization. The compressed wood was treated with paraformaldehyde and SO_2 in the dry condition at 135°C for 20 min. The deformation was perfectly fixed even after boiling for an hour. The same results were obtained by the reaction at 120°C for 2 hours with teraoxane as a formaldehyde vapor source. The third method is through releasing the elastic energy stored by deformation, which results from the decomposition of the molecular chain in wood constituents. Recovery of compressive deformation was decreased with increasing dipping time in aqueous solution of acetic acid and hydrochloric acid.

Uniaxial modelling of vibrational properties of chemically modified wood, H. AKITSU, J. GRIL and M. NORIMOTO: *Mokuzai Gakkaishi*, **39**(3), 258–264 (1993).

The effect of chemically modified wood structure on the specific longitudinal dynamic Young's modulus (E'/γ) and loss tangent ($\tan \delta$) was analyzed by using rheological analogies. Comparison with experimental data, after eliminating the effect of volume and weight increase, allowed an estimate of the changes in rigidity and viscosity of the amorphous regions of the cell wall (matrix). In a formaldehyde treatment, a rigidity increase and an even more pronounced viscosity increase were evidenced and attributed to matrix crosslinking. In acetylation and epoxide treatments, swelling alone would have decreased E'/γ and increased $\tan \delta$; the observed $\tan \delta$ decrease in the first case and the increase in the second was explained by the hydrophobic or hydrophilic nature of the respective bulking agents. PEG (polyethylen glycol) molecules both provoked swelling and reduce matrix rigidity and viscosity. In the case of wood plastic composite with the filling of lumens only the effect of the treatment depended greatly on the viscoelastic properties of the resin introduced: usually the weight increase should induce a marked decrease of E'/γ , and a simultaneous E'/γ increase and a $\tan \delta$ decrease are difficult to obtain.

Humidity conditions by finish materials, T. OHGAMA, M. NORIMOTO and J. KOHARA: *J. Japan Soc. for Interior Studies*, No. 3, 41–46 (1993).

The relative humidity as a function of temperature in a closed steel box lined with finish materials was measured when its ambient temperature was changed periodically. The logarithm of relative humidity was represented approximately by a linear equation of temperature. The degree of humidity conditions by finish materials in the box was evaluated by the slope B of the equation. The relationship between the B-value and the ratio of lined area to volume of the box (A/V) for finish materials were obtained. The

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B-value at the A/V value which corresponds to that in a six-mat room were also measured in the case lined with combinations to different finish materials. It was showed that the degree of humidity conditions in the latter case could be evaluated by the corresponding B-values of wood determined from the sum of A/V values of wood equivalent to the B-values at respective lined areas of finish materials.

Effect of humidity on vibrational properties of chemically modified wood, H. AKITSU, M. NORIMOTO, T. MOROOKA and R.M. Rowell: *Wood and Fiber Sci.*, **25**(3), 250–260 (1993).

Changes in vibrational properties of wood can be used to determine changes in the wood cell wall resulting from chemical modification. The dynamic Young's modulus to specific gravity ratio (E'/γ) and internal friction ($\tan \delta$) for chemically modified wood compared to those for untreated wood showed major differences in cell-wall modification and lumen filling modification. Increasing the moisture content of the cell wall also has a major effect on the vibrational properties of chemically modified wood. In general, treatments that resulted in lowering the moisture content of the cell wall also lowered friction within the cell wall. Vapor phase reactions with formaldehyde had the greatest effect in stabilizing the cell wall against changes in dynamic mechanical properties with increasing moisture content.

Steam or heat fixation of compressed wood, M. INOUE, M. NORIMOTO, M. TANAHASHI and R.M. ROWELL: *Wood and Fiber Sci.*, **25**(3), 224–235 (1993).

Dimensional stability can be improved by either steaming or heating wood while the wood in a compressed state. This study investigated the effect of steam or heat on fixation of compression set and the effect of these treatments on hardness, mechanical properties, and color of compressed and uncompressed wood specimens. To determine the effect of steaming before and after compression set, one group of wood specimens was steamed and compressed, and another group was compressed and then steamed. Simple boiling and cyclic swelling tests were used to evaluate recovery of compression set. Hardness of compressed specimens was measured by the Brinell test. A two-point bending test on noncompressed specimens was used to calculate moduli of elasticity and rupture. A L-a-b color system was used to determine color changes. Compressed wood steamed for 1 min at 200°C or 8 min at 180°C showed no recovery of set, large increases in hardness, minimum decreases in mechanical properties, and slight darkening. We conclude that almost complete fixation of compression set in wood can be achieved by steaming compressed wood.

Dielectric relaxation of water adsorbed on Wood II, M. NORIMOTO and G. ZHAO: *Mokuzai Gakkaishi*, **39**(3), 249–257 (1993).

To clarify the mechanism of the dielectric relaxation of the water adsorbed on wood,

dielectric measurements of trityl and acetyl celluloses as well as cellulose containing various amounts of water were made. Two relaxations due to the adsorbed water for trityl and acetyl celluloses were observed, but only one relaxation for cellulose. However, the dielectric behavior of cellulose at a relative humidity less than about 60% was very different from that at a relative humidity of more than 60%. Thus it was considered that two relaxations due to adsorbed water existed in cellulose. These two relaxations for cellulose had close resemblances in characteristics to those for trityl and acetyl celluloses. It is supposed that the relaxation of the adsorbed water for cellulose at the smaller relative humidity resulted from the reorientation of one water molecule accompanied by the scission of about two hydrogen bonds, whereas that at the greater relative humidity resulted from the simultaneous reorientation of plural water molecules.

Dimensional stability, mechanical properties, and color changes of a low molecular weight melamine-formaldehyde resin impregnated wood, M. INOUE, S. OGATA, M. NISHIKAWA, Y. OTSUKA, S. KAWAI and M. NORIMOTO : *Mokuzai Gakkaishi*, **39**(2), 181–189 (1993).

Specimens of sugi (*Cryptomeria japonica* D. Don) wood were treated with water soluble melamine-formaldehyde resin with low molecular weights. The dimensional stability with moisture, the mechanical properties, and the color changes caused by the treatment were investigated. The results obtained were as follows:

With increase in resin concentrations, the weight percent gain (*WPG*) increased. Both the bulking efficiency (*BE*) and the antiswelling efficiency (*ASE*) were increased up to about 15% concentration (*WPG*: 22–34%), followed by a leveling off. The treated specimens at a 25% concentration (*WPG*: 58%) had *BE* and *ASE* of about 5 and 42%, respectively. Both *BE* and *ASE* of the treated specimens maintained stability during wetting and drying cycles, but with boiling they decreased drastically.

The increases in the modulus of elasticity (*MOE*) and the modulus of rupture *MOR* at a 25% concentration were about 10% and 18%, respectively. However, slight decreases in *MOE* and *MOR* were detected at the low levels of concentrations below 5%. Remarkable decreases in abrasion resistance and linear increases of the surface hardness with increasing concentrations were observed.

The color changes by the treatment were not significant. Those with irradiation of a sunshine carbon-arc light became smaller with increasing concentrations.

Fire-resistant carbon-board materials. II. Fire endurance, electromagnetic shielding, and sound insulation performances of particleboards overlaid with graphite-phenolic spheres, I. IDE, S. ISHIHARA, S. KAWAI, Y. YOSHIDA, M. NAKAJI and A. TAKAMATSU : *Mokuzai Gakkaishi*, **38**, 777–785 (1992).

Graphite phenol-formaldehyde spheres (GPS) were produced by phenol-formaldehyde

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condensate on graphite powder. The resulting thermosetting resin, in powder form, was used as an overlay for both surfaces of particleboard cores in the production of actual size fire-resistant board.

The effects of the weight ratio of the GPS (surface) layer to the board, on fire integrity, fire endurance, electromagnetic shielding, and sound insulation performance of the GPS-overlaid particleboards were evaluated.

The results were as follows :

The fire integrity and endurance of 40 mm thick GPS-overlaid particleboards under fire tested according to the JIS (Japanese Industrial Standard) A 1304 fire test were more than 80 minutes with 10, 20, and 30% weight ratios of GPS overlays.

Boards exposed to fire did not show any burn-through even after the unexposed surface exceed the critical temperature of 260°C.

The sound pressure level of a double wall of GPS-overlaid particleboard had a sound insulation classification of D-50 noted in JIS A 1419.

The shielding efficiency of 30 mm thick and 0.60 g/cm³ dense overlaid board with 10% GPS was over 40 dB against electric fields.

Carbon composites from wood charcoal as an electromagnetic shield and fire resistive material, S. ISHIHARA: All Div. 5 Conferenc, International Union of Forestry Research Organizations, France, Proc. Actes, vol. 1, 125–127 (1992).

Various kinds of wood charcoal were used in the manufacture of fire resistive and electromagnetic shield composites. Relationships between carbonizing temperature and the fire resistive property and electromagnetic shielding property of the carbon composites were discussed. Fire resistivity of the carbon composites were tested by an oxygen index method in accordance with the Japan Industrial Standards (JIS) K 7201, by a burn-through method, and by cutting with an oxy-acetylene torch. Electromagnetic shielding property of the composites was tested by DUAL chamber method in accordance with ASTM E84-83. Fire resistive and electromagnetic shielding effect of composites from wood and wood components were improved by the increase of carbonizing temperature.

Fire protected wood products through science, M. KOSIK, I.G. ROMANENKOV, A. KREITUSS, S. ISHIHARA, T.N. SYACHRI and S.S. ACHMADI: All Div. 5 Conference, International Union of Forestry Research Organizations, France, Proc. Actes, vol. 1, 409–419 (1992).

The joint paper is devoted to the short description of the present state in fire protection in selected different areas of the world. Authors would like to show the main problems which are the matter of some research topics and the problems concerned with the application of fire retardants for wood products, mainly materials for the construction and fire protection of buildings. The review is not exhausting and it depends on the own

selection of each author. Further more, we believe that the paper can show the problems which are the most frequently discussed in each of the selected countries.

Fire endurance and electromagnetic shielding effectiveness of carbon-based Composites, S. ISHIHARA, I. IDE, C. NAGASAWA and S. KAWAI: *J. Soc. Mat. Sci., Japan*, **42**, 147–152 (1993).

Graphite and phenol-formaldehyde resin spheres (GPS) were used in the manufacture of fire resistive and electromagnetic shield composites. The effects of specific gravity, thickness and phenol-formaldehyde resin content of GPS on the fire resistivity and electromagnetic shield of composites were discussed. The carbonizing temperature of the composites relative to the fire resistive and electromagnetic shielding properties was also discussed. The fire resistivity was tested by a burn-through method, by cutting with an oxygen-acetylene torch and by an oxygen index method in accordance with the Japanese Industrial Standards (JIS) K 7201. The electromagnetic shielding property was tested by a DUAL chamber method in accordance with ASTM ES-7-83. The fire resistive and electromagnetic shielding properties of the composites were improved by increasing the specific gravity and thickness of the GPS composites as well as increasing the carbonizing temperature, and reducing the phenol-formaldehyde resin content.

Improvement of the durability of wood with acry-high-polymer V. Adsorption of hydrophilic acrylic polymer onto wood swollen with acetone, T. FUJIMURA, M. INOUE, T. FURUNO, Y. IMAMURA and S. JODAI: *Mokuzai Gakkaishi*, **39**, 315–321 (1993).

To clarify the behavior of polymer adsorption onto wooden materials, a piezoelectric quartz crystal was used as a balance scale of micro-gram range. Carboxymethyl cellulose (CMC) was cast on the electrodes of the quartz crystal. For measuring the resonance frequency shifts in several solvents, oscillation circuits were made. The resonance frequencies of the quartz crystal in solvents and in acrylic copolymer solution of copolymer is monolayer because the Langmuir plots of the copolymers were on straight lines. The saturated amounts of adsorption of copolymers having hydrophilic groups, such as OH groups, onto the CMC-cast electrodes were 122 to 306 ng/cm². According to the difference between the saturated amount of adsorption calculated from the value of the resonance frequency shift and that calculated from the radius of gyration in the copolymer solution, the deformations of these copolymers adsorbed on the CMC films were compressed 1/3 to 4/5 in comparison with the forms of these copolymers in acetone. For the compressibilities of these copolymers, the more hydrophilic copolymers having larger radius of gyration were compressed more greatly than other copolymers.

Improvement of the durability of wood with acryl-high-polymer VI. Polymer adsorption on piezoelectric quartz crystal coated with carboxymethyl cellulose, T.

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FUJIMURA, T. FURUNO, Y. IMAMURA and S. JODAI: *Mokuzai Gakkaishi*, **39**, 658–666 (1993).

To clarify the adsorption mechanism of an acyclic copolymer, containing, OH groups, onto wood, the effects of the composition and the radius of gyration (RG), calculated from the intrinsic viscosity of the copolymer, on the behavior of adsorption were investigated. The adsorption isotherm, corrected by using Shiraishi's equation, reached plateaus in the range of 1 to 1.5% of the equilibrium concentration of the copolymer solution. The adsorption of such copolymers is said to be monolayer because of the straight lines expressed by their langmuir plots. It was assumed that the polymer adsorbed onto the wood and almost in to the cell walls because the adsorption amount on the surfaces of permanent voids was calculated to be about 1.5 mg/g. Therefore, the polymer in the cell walls was estimated as 30–40 mg/g equivalent to 1/5–1/7 of the maximum amount of copolymer existing in the transient pores in their solid-state densities. The RGs of these copolymers in acetone increased with increases in the hydrophile property of the copolymers and their molecular weights. The saturated amounts of adsorption are considered to be affected by the affinities between the wood and the copolymers when the RGs of the

Improvement of liquid penetration of wood by precompression under appropriate conditions and recovery process, I. IIDA and Y. IMAMURA: *The Int. Res. Group on Wood Preserv. Document*, No. IRG/WP/93-40014, pp. 1–10 (1993).

A new system for enhancing the penetration of liquid into wood using a precompression treatment was designed, and the effects of compressive deformation and recovery on liquid uptake were evaluated. Precompression of up to 60% under appropriate moisture and heat conditions effectively increased the penetration of liquid into refractory wood samples of practical sizes without producing any strength reduction. Water-saturated wood was compressed perpendicularly to the grain at temperature of 30°C to 80°C, and two types of pretreated wood were prepared; i.e., set-recovered wood in which loading was released immediately after precompression, and prest-fixed wood which was released immediately after precompression, and preset-fixed wood which was dried under the influence of a decompressive force. The amount of liquid taken up by set-recovered wood was 2–3 times that taken up by untreated wood. When preset-fixed wood was dipped in liquid and the deforming force was released, liquid penetration was more than 25 times that seen in untreated softwood heartwood. Liquid effectively penetrated even long samples when pressure impregnation was applied to precompressed and prest-fixed wood. No significant reduction of strength was observed for treated wood except for that which had been precompressed up to 60%. Fracture of pit membranes during compression with little damage to unpitted cell-walls and an elastic recovery process were believed to improve liquid penetration with negligible compression defects.

Recent trend and future view of wood utilization for out-door uses, Y. IMAMURA : *Mokuzai Hozon (Wood preservation)*, **19**, 77–81 (1993) (in Japanese).

Presentations of the symposium on “Recent trend and future view of wood utilization for out-door uses” were summarized.

Properties of wood and wood-based materials, Y. IMAMURA : “A handbook of wood preservation” (Ed. by Japan Wood Preservation Association), pp. 1–11 (1992) (in Japanese).

The structural properties of wood and wood-based materials related to wood preservation were outlined.

Production of particleboards with a steam-injection press VI. Effects of particle geometry on board properties, T. HATA, S. KAWAI, T. EBIHARA and H. SASAKI : *Mokuzai Gakkaishi*, **39**, 169–173 (1993).

Each of seven types of Japanese red pine particles (*Pinus densiflora* Sieb. et Zucc. spp.) with different dimensions, strictly controlled for length (l), width (w), and thickness (t), was prepared in producing particleboards with a density range of 0.3–0.6 g/cm³ under different pressing conditions. Mechanical and physical properties of these boards were determined and the effects of particle geometries and pressing conditions are discussed. The modulus of elasticity (MOE) and the modulus of rupture (MOR) were almost independent of t when l was 80 mm. The internal bond strength (IB) had a tendency to decrease when l was 20 mm and t was 0.9 mm. The thickness swelling (TS) had a tendency to increase with an increase of l . The IB of 0.6 g/cm³ density boards produced by steam-injection decreased. Other properties were influenced less by the timing of the steam-injection.

Production of particleboards by a gassing process, T. HATA and T. EBIHARA : *New Zealand FRI Bull.*, No. 176, 64–72 (1992).

A gassing process in which adhesives are cured with amine gas was investigated in order to more efficiently produce thicker particleboards using less energy than the conventional hot-platen pressing method. Particleboards (0.6 air dry density, 400×400×20 mm board size) were produced using Japanese red pine particles (0.4 air dry density, 12% moisture content). The boards were manufactured by changing the platen temperature, gas injection pressure (the gas concentration) and moisture content of particles. The physical and mechanical properties were then investigated. The flexure properties and the internal bond strength of the boards increased with an increase in the platen temperature, however, good board properties could be obtained at the temperature of 60°C. The internal bond strength improved because of the uniform density distribution. In this process particle moisture content is an important factor.

Production of Particleboard with a steam-injection press V. Effects of particle geometry on temperature behaviors in particle mats and on air permeabilities of boards, T. HATA, S. KAWAI, T. EBIHARA and H. SASAKI : *Mokuzai Gakkaishi*, **39**(2), 161–168 (1993).

Each of seven types of Japanese red pine (*Pinus densiflora* Sjev et Zucc.) particles with different dimensions, strictly controlled for length (l), width (w), and thickness (t), were prepared in an investigation of the temperature behavior in the mat, and the air permeability of the boards with specific gravities of 0.30–0.60. The variables influencing the temperature behavior in the mat by a steam-injection press are related to the air permeability of the mats. The air permeability of the boards in the direction horizontal to the heat platen is always more than in the vertical direction. A functional equation with a greater coefficient of determination that explains the air permeability is obtained by a multiple regression analysis. It is inferred that the temperature increase in the mat results from a repetition of the steam diffusion among particles in two dimensions.

Micobiological deterioration of wood (Kingai, Mokuzai no seibutsu rekka), M. TAKAHASHI : “Text Book of Wood Preservation (Mokuzai Hozongaku Nyuumon)”, Japan Wood Preserving Association ed., p. 47–63 (1992) (in Japanese).

Characteristics of wood-deteriorating microorganisms, and related changes in wood properties were described.

Guidelines of laws, codes and standardized test methods relevant to wood preservation in Japan (Mokuzai hozon ni kanrensuru kokunai no kankei houki, shishin tou no kaisetsu), M. TAKAHASHI : “Guidelines for scientists engaged in control of environmental microbes (Kankyo bisseibutsu seigyō gijutsusya no tebiki)”, The Society for Antibacterial and Antifungal Agents, Japan ed., Giho-do Publishing, p. 101–105 (1993) (in Japanese).

Laws, codes and standardized test methods which are related to wood preservation in Japan were briefly described.

Enhancement of biological resistance of wood by non-toxic chemical treatment, M. TAKAHASHI, J.-Y. RYU, S. YUSUF, K. TSUNODA, Y. IMAMURA and H. KAJITA : Proceedings of The 4th JSPS-VCC Seminar on Integrated Engineering, October 13–14, 1992, Kyoto, p. 111–120 (1992).

Among the various non-toxic chemical treatments to prevent biodeterioration of wood, acetylation, phenolic resin impregnation and wood-inorganic material composite are worthy of consideration for their potential practical use. These treatments are more applicable to reconstituted wood products than to thick solid timber since the chemicals penetrate easily into the wood cell walls and voids in small-size elements. Improved resistance against

decay fungi and termites by these treatments are described.

Biological resistance of phenolic resin-treated wood incorporating boric acid impregnation, J.-Y. RYU, Y. IMAMURA and M. Takahashi: *FRI Bulletin*. No. 176, 107-116 (1992).

Biological resistance and dimensional stability in PF (phenol formaldehyde) resin-treated wood was investigated in relation to the effect of pre-impregnation of boric acid and its mixing with the PF-resin. Sapwood blocks of Japanese cedar, pine and beech were vacuum-impregnated with several concentrations of low molecular weight PF-resin (Mw: 170) solutions after pretreatment with 1% solution of boric acid, or with the same concentrations of the PF-resin solution mixed with 1% boric acid. Air-dried blocks were heat cured to insure the polymer formation in wood structure, immersed in water for one week to leach away the unpolymerized resin and boric acid, re-dried, and exposed to decay fungi and subterranean termites.

Both ways to boric acid impregnation affected the PF-resin treated wood to yield the higher biological resistance at lower RL (resin loading) than in sole PF-resin treatment. Effectiveness in preventing decay was far better for a white-rot fungus *Coriolus versicolor* than for a brown-rot fungus *Tyromyces palustris* tested, and better for cedar and pine than for beech. For the enhancement of biological resistance, the treatment with mixing solution of PF-resin and boric acid was better than the separated treatments with these chemicals.

Effects of molecular weight and some other properties of resins on the biological resistance of phenolic resin treated wood, J.-Y. RYU, Y. IMAMURA, M. TAKAHASHI and H. KAJITA: *Mokuzai Gakkaishi*, 39, 486-492 (1993).

Biological resistances of PF(phenol formaldehyde)-resin treated woods were investigated in relation to the Mw (number-average molecular weight) and some other properties of resins. Seven resins, of which three (Mw: 369, 621, and 1,143) and other (Mw: 383, 545, 791, and 991) supplied by two different manufactures, were used for the treatments. Sapwood blocks of Japanese cedar (*Cryptomeria japonica* D. Don) were impregnated with various concentrations of PF-resin solutions, heat cured, and exposed to decay fungi and subterranean termites. In both resin groups, the smaller Mw resins had the greater biological resistances than the larger Mw ones. However, from a comparison of results between the two groups of resins, the resistances might have been affected not only by Mw but also by the molecular weight distributions and pH of the resins. The small Mw PF-resins, which consisted exclusively of monomeric phenol alcohols with two or three reactive alcohol groups and having smaller alkalinities considered promising for the production of biologically-resistant wood materials.

Oligoesterified woods based on anhydride and epoxide IX. Decay and termite resistance of oligoesterified woods, K. MURAKAMI, H. MATSUDA, M. UEDA, J.-Y. RYU, Y. IMAMURA and M. TAKAHASHI: *Mokuzai Gakkaishi*, **39**, 436–445 (1993) (in Japanese with English summary).

Decay and termite resistances were investigated for oligoesterified woods prepared by using phthalic anhydride (PA) and epichlorohydrin (EpCl) as reactants. The oligoesterification was conducted by heating sapwood blocks of two softwood and one hardwood species which had been impregnated with reactant solutions of PA and EpCl, and then subjecting them to heating-suction to remove unreacted reactant solutions.

For a brown-rot fungus *Tyromyces palustris* (Berk. and Curt.) Murr., when the apparent total weight increase (TWI) due to oligoesterification increased to more than 20%, no mass losses of the specimens were observed in all wood species examined. Meanwhile, for a white-rot fungus *Coriolus versicolor* ((L. ; Fr.) Quel.), the mass loss became very small at about 10% TWI in hinoki (*Chamaecyparis obtusa* Endl.) and Sugi (*Cryptomeria japonica* D. Don) blocks. In buna (*Fagus crenata* Bl.) blocks, the chemical treatment effect was insufficient at about 10% TWI, but the mass loss was reduced considerably at more than 20% TWI. The greatly improved resistance against bacteria or soft-rot fungi also was evaluated through long-term exposure in moist, unsterile soil. Scanning electron microscopic observation disclosed that destruction of pit and unpitted regions of the cell walls due to fungal attacks became negligible with increases of the degree of treatment.

Furthermore, the mass loss due to attacks by termites (*Coptotermes formosanus* Shiraki) in forced-feeding tests became very small at about 10% TWI, and the termite mortality increased gradually suggesting digestive-impeding effects of the treatment without the toxic effects.

Fungal detoxification of organoiodine wood preservatives Part 2. Fungal metabolism in the decomposition of the chemicals, D.-H. LEE, M. TAKAHASHI and K. TSUNODA: *Holzforschung*, **46**, 467–469 (1992).

Fungal metabolic activities in the decomposition of four organoiodine wood preservatives: 4-chlorophenyl-3-iodopropargyl formal (IF-1000), 3-iodo-2-propynyl butyl carbamate (IPBC), 3-bromo-2,3-diiodo-2-propenylethyl carbonate (EBIP), and 2,3,3-triiodoallyl alcohol (TIAA) were examined using intact fungal cells extracellular and intracellular fraction and cell wall components of three decay fungi *Tyromyces palustris*, *Serpula lacrymans*, and *Coriolus versicolor*. Contact of the fungicides with the fungal cell wall components unexceptionally caused the high degradation rates. *C. versicolor* exhibited the highest potential in degrading the fungicides extracellularly and/or intracellularly, followed by *S. lacrymans* and *T. palustris*.

Fire resistance of wood-inorganic material composites (II), S. HIRAO, H. USUI, K. ONISHI, K. TSUNODA and M. TAKAHASHI: *FRI Bulletin*, No. 176, 124–129 (1993).

Wood-inorganic material composites (WIC) which were produced by double diffusion process proved to be as resistant to fire as cemented chip board in some standardized tests. High fire resistance of the new products seemed to largely depend on coating effect of water-insoluble deposits formed within timber during the process. In heating test for 60 minutes the newly developed materials were superior to those which were conventionally treated with water-soluble inorganic salts in terms of combustion rate.

When a fire proof door was made of WIC and served for comparative fire test with another fire proof door made of commercially available treated plywoods, the new door performed much better than reference plywood samples.

Distribution of the three symbiotic protozoa in Formosan subterranean termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae), T. YOSHIMURA, K. TSUNODA and M. TAKAHASHI: The Int. Res. Group on Wood Preserv., Document No. IRG/WP93-10010 (1993).

Six colonies (three each from laboratory and field) of Formosan subterranean termite, *Coptotermes formosanus*, were served for investigating the abundance and distribution of three symbiotic protozoa in the hindgut of workers. The total protozoan number amounted to 6,000–10,000 per a worker, and the order of the abundance of the three protozoa and the proportional distribution of each species in the hindgut were common among the colonies. *Pseudotrichonympha grassii* Koidzumi was the smallest in number (800–2,200 per a worker) and was preferentially distributed in the anterior part of the hindgut. *Holomastigotoides hartmanni* Koidzumi was medial in number (1,200–3,000), and the distribution was relatively uniform all through the hindgut. *Spirotrichonympha leidy* Koidzumi was the most abundant in number (2,800–5,000) and was found mainly in the posterior part. These results appeared to support that the prominent localization of each protozoan species in the worker's hindgut could be related to the nutritional metabolism in *C. formosanus*.

Termiticidal efficacy of synthetic pyrethroids (I). Laboratory evaluation of cyhalothrin and lambda-cyhalothrin as termiticides, K. TSUNODA and M. TAKAHASHI: *Jpn. J. Environ. Entomol. Zool.*, 4(4), 173–179 (1992).

Two synthetic pyrethroids [cyhalothrin: (RS)-alpha-cyano-3-phenoxy-benzyl (Z)-(1RS, 3RS)-3-(2-chloro-3,3,3-trifluoropropenyl)-2,2-dimethylcyclopropanecarboxylate and lambda-cyhalothrin: alpha-cyano-3-phenoxybenzyl 3-(2-chloro-3,3,3-trifluoropropenyl)-2,2-dimethylcyclopropanecarboxylate, a 1:1 mixture of the (Z)-(1R, 3R), S-ester and (Z)-(1S, 3S), R-ester] were tested for their termiticidal effectiveness in standardized laboratory tests prescribed in Japan Wood Preserving Association (JWPA) Standards 11(1) (1981) and 13 (1987). When the chemicals were used to treat sapwood blocks of *Pinus densiflora* Sieb, et

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Zucc. ($1 \times 1 \times 2$ cm) by brushing at a rate of 110 ± 10 g/m² [timber treatment], the treated wood blocks were well protected from the attack of subterranean termites, *Coptotermes formosanus* Shiraki at the lowest test concentration [0.1% (w/v) for cyhalothrin and 0.05% (w/v) for lamda-cyhalothrin] regardless of weathering. In a tunnelling test [soil treatment], 3g of a treating solution of the required concentrations [0.1, 0.2, and 0.4% (w/v) for cyhalothrin and 0.05, 0.1, and 0.2% (w/v) for lamdacylhalothrin] was incorporated into the soil and the test termites were forced to penetrate into the treated zone. Cyhalothrin and lamda-cyhalothrin could meet the performance requirement at 0.4 and 0.1% (w/v) respectively even after weathering, although unweathered samples would not allow termites to penetrate further than 1cm at lower concentrations. These results of standardized laboratory evaluation definitely demonstrated the high potential of the two synthetic pyrethroids as termiticides, and further investigations including some field tests should be planned to examine their practical applicability.

On the 23rd conference of the IRG on wood preservation, K. TSUNODA: *Termite (Shiroari)*, No. **91**, 3–9 (1993) (in Japanese).

Reorganization and new structure of the IRG and scientific documents relevant to termite research which were presented at the 23rd annual conference of the IRG held in Harrogate, U.K. on 10–15 May, 1992 were outlined with a few tables and figures.

Biological resistance of wood-inorganic material composites (II), K. TSUNODA, T. YOSHIMURA, M. TAKAHASHI, S. HIRAO, H. USUI and S. KONISHI: *FRI Bulletin*, No. **176**, 117–123 (1992).

Sound sapwood specimens with a size of 20 (T) \times 20 (R) \times 10 (L) mm were prepared from *Cryptomeria japonica* D. Don to serve them as substrate for double diffusion treatment. Treatment was done by consecutive dipping at 80°C for 24 hours in each different aqueros solution and followed by washing in non-running water at room temperatures for 85 hours. Water-insoluble deposits (such as barium hydrogenphosphate, barium sulfate, calcium hydrogenphosphate and calcium sulfate) were formed during the treatment. In order to examine the effect of adding boric acid to treating solutions on wood-preservative performance, the treated materials were tested for their resistance against decay fungi and termites in the laboratory.

Target weight percent gain (10–50%), regardless of kinds of water-insoluble deposits formed within timber, was high enough to prevent decay by a white rot fungus, *Coriolus versicolor* (Linn. ex Fri.) Quel. especially when a small amount of boric acid was added to the second treating solution. Similarity was noticed with a brown rot fungus, *Tyromyces palustris* (Berk. et Curt.) Murr., although the higher fungicidal efficacy was recorded by the addition of boric acid in both treating solutions.

When boric acid was incorporated at least in the second treating solution, barium

hydrogenphosphate seemed to perform better than any other deposits against subterranean termites, *Coptotermes formosanus* Shiraki on the basis of weight percent losses of the test materials and mortality of termites during the 3-weeks' test duration.

The present results suggested that the relatively lower weight percent (definitely less than 10%) increase by deposits could protect timber from biodeterioration.

Distribution of the symbiotic protozoa in the hindgut of *Coptotermes formosanus* Shiraki (Isoptera : Rhinotermitidae), T. YOSHIMURA, K. TSUNODA and M. TAKAHASHI: *Jpn. J. Environ. Entomol Zool*, **4**(3), 115-120 (1992).

Four colonies (three laboratory + one field) of *Coptotermes formosanus* Shiraki were used to investigate the abundance and distribution of three symbiotic protozoa in the hindgut of workers with a special reference to their wood-eating activity. *Pseudotrichonympha grassii* Koidzumi, the largest species, was the smallest in number among three species and preferentially distributed in the anterior part of the hindgut. *Holomastigotoides hartmanni* Koidzumi was medial in both size and number, and their distribution was relatively uniform all through the hindgut. Most of *Spirotrichonympha leidy* Koidzumi the smallest species and most abundant, were distributed in the posterior part. A characteristic localization of the symbionts thus was demonstrated. In a field colony, the population of *P. grassii* and *H. Hartmanni* was much smaller than that of laboratory colonies, which may have decreased their wood-eating activity. These results seemed to support the idea that *P. Grassii* and/or *H. hartmanni* played an important role in cellulose metabolism of *C. formosanus*.

Distribution of the cellulolytic activities in the lower termite, *Coptotermes formosanus* Shiraki (Isoptera : Rhinotermitidae), T. YOSHIMURA, T. WATANABE, K. TSUNODA and M. TAKAHASHI: *Material und Organismen*, **37**, 273-284 (1992).

Distribution of the cellulolytic activities in the lower termite, *Coptotermes formosanus* Shiraki was investigated with a special reference to the characteristic localization of three symbiotic protozoa in the hindgut of workers. CMC-degrading activity was mainly present in the parts other than hindgut (63%), whereas 87% of Avicel-degrading activity was obtained from the hindgut. β -D-glucosidase activity in the hindgut did not differ from that in other parts. *Pseudotrichonympha grassii* Koidzumi-the largest in size and the smallest in number among three protozoan species - was preferentially found in the anterior part of the hindgut. *Holomastigotoides hartmanni* Koidzumi - the medial in both size and number-was uniformly distributed through the hindgut. Most of *Spirotrichonympha leidy* Koidzumi - the smallest in size and the most abundant in number - was localized in the posterior part. On the basis of the relation between the cellulolytic activities and the localization of symbionts in the hindgut, it seemed that cellulose was degraded through complex synergistic action of termites themselves and the symbiotic protozoa in *C. formosanus*.

Abstract

Cellulose metabolism of the symbiotic protozoa in termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae) I. Effect of degree of polymerization of cellulose, T. YOSHIMURA, J. AZUMA, K. TSUNODA and M. TAKAHASHI: *Mokuzai Gakkaishi*, **39**, 221–226 (1993).

To explain the role of three species of symbiotic protozoa in the cellulose metabolism of termite, *Coptotermes formosanus* Shiraki, the effect of the degree of polymerization (DP) of cellulose on changes of survivals, weights and protozoan fauna was examined when termite workers were forced to feed on test materials.

The changes of survivals and weights of workers clearly indicated that workers of *C. formosanus* could utilize wood meal, fibrous cellulose powder and low-molecular weight celluloses (LCs) having different mean degree of polymerization ($\overline{DP}=27$ and 17) as their nutrients. Feeding on LCs resulted in the drastic disappearance of the largest protozoa, *Pseudotriconympha grassii* Koidzumi within four weeks, whereas the two smaller species, *Holomastigotoides hartmanni* Koidzumi and *Spirotrichonympha leidy* Koidzumi proved to be alive even after 12 weeks.

These results showed that *P. grassii* required relatively large DP cellulose as nutrients, and that *H. hartmanni* and/or *S. leidy* could supply the hosts' nutrient requirements by decompositions of LCs to some extent with the absence of *P. grassii*. They also suggested that the DP of cellulose was related closely to the utilizations of cellulose by each protozoan species.

Cellulose metabolism of the symbiotic protozoa in termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae) II. Selective defaunation of protozoa and its effect on cellulose metabolism, T. YOSHIMURA, J. AZUMA, K. TSUNODA and M. TAKAHASHI: *Mokuzai Gakkaishi*, **39**, 227–230 (1993).

The largest protozoa, *Pseudotriconympha* Koidzumi, in the workers of *Coptotermes formosannus* Shiraki was selectively defaunated. The defaunated workers were employed in examining whether or not they could utilize cellulose substrates with large DP such as akamatsu (*Pinus densiflora* Sieb. et Zucc) wood meal and fibrous cellulose powder along with the other two protozoa, *Holomastigotoides hartmanni* Koidzumi and *Spirotrichonympha leidy* Koidzumi.

From the results on forced-feeding of the defaunated workers, *H. hartmanni* and *S. leidy* were shown not to utilize native greatly polymerized cellulose as their nutrients. The protozoa probably have their inherent roles in the metabolism of cellulose.

The Needs and Frontier in the Field of Wood Composites, H. SASAKI: Forest (SAN-RIN), No. 1301, 2–11 (1992) (in Japanese).

The development of new types of wood composites with adaptability of the factory automation is needed as the quality of wood raw materials decreases and the labour cost for

the production increases. There are a lot of technological problems to be solved. However, the assessment of the social influences to wood industries is becoming more important than the development of new wood composites for expanding the demand on wood-based materials. Especially the establishment of the proper relation between the utilization of wood resources and the global environment problems is urgently needed.

Production of Wood Composites and the Secondary Processing, H. SASAKI : Partial author of a book "Fundamentals of Wood Science" edited by the Kansai Branch of the Japan Wood Technological Association, 113-144 (1992) (in Japanese).

The classification of wood composites is newly proposed in respect to the size and orientation of the elements. Wood composites for structural use are called Engineered Woods. The production technology of these materials are introduced and the future system is discussed. The evaluation of production systems of every wood composite is made in respect of the energy consumption, yield of the products, adaptability to the factory automation, deviation of the properties etc. Selection of adhesives for each field of use, aligning strand type particles, chemical processing of wood elements are discussed. The final section is an introduction of the second processing of wood composites.

Bearing loads of wood glue joints under fire I. Effect of adherent thickness and adhesive types on fire endurance, Q. WANG, S. KAWAI, S. ISHIHARA and H. SASAKI : *Mokuzai Gakkaishi*, **39**(4), 428-435 (1993) (in Japanese).

Glue-joint test specimens were made with three adhesives, that is, epoxy resin, aquapolymer-isocyanate resin, and resorcinol resin, and the potential bonding strengths of glue-lines exposed to fire were examined. The results were as follows :

1. The temperature of a glue-line at failure shows an inherent value for every adhesive almost without regard to the adherend thickness. Compared with the same adherend thickness, the fire endurance of glue-line lessens in the order of resorcinol resin, aquapolymer-isocyanate resin, and epoxy resin. The fire endurance of epoxy resin is remarkably inferior and is about a half of that of resorcinol resin.

2. The bonding strength of epoxy resin is reduced suddenly at about 40-70°C of glue-line temperature and at over 70°C showing it as less than 1/4 of bonding strength at room-temperature. The bonding strengths of resorcinol resin and aquapolymer-isocyanate resin decrease gradually with increases of temperature. Even at more than 250°C, these bonding strengths were maintained at about 30 kgf/cm².

3. The potential bonding strength of a glue-line exposed to fire is linearly reduced with exposure time to the fire. In a comparison of the rates of deterioration, epoxy resin is the fastest, aquapolymer-isocyanate resin is the second, and resorcinol resin is the slowest of the three.

Utilization of laminated-veneer-lumber from Sabah plantation thinnings as beam flanges III. Production of composite beam and its properties, Q. WANG, S. SASAKI, P. YANG and S. KAWAI: *Mokuzai Gakkaishi*, **38**(10), 914–922 (1992) (in Japanese).

The mechanical properties of composite beams with webs composing of low-density particleboards from lauan (*Shorea* spp.) semi-flakes, and flanges of LVL from two fast growing species [*Eucalyptus deglupta* Bl. (ED) and *Alibiza falcata* Back. (AF)] from Sabah Forest Plantation thinnings were investigated. Considering the failure behavior of the composite beams, the maximum stresses under loading condition were numerically analyzed with the finite element method (FEM) and compared with those calculated by the empirical formulas of the strength of materials. The results are as follows:

1) The modulus of elasticity (MOE) and modulus of rupture (MOR) of the composite beams were low but the coefficients of variation were small compared to LVL and dimension lumbers of the same species as the flange veneers. Therefore the resulting allowable stress in bending of the composite beams suggests that the composite beams is potentially useful for structural purposes.

2) No bending failure was observed during central loading test when the span was shortened, although shear failure occurred along the glue line of the flange and web interface.

3) The span length at the transition of failure mode shear to bending in experiment did not correspond with the critical span length predicted by the empirical formulas using the strength of constitutional elements, elastic constant, etc.

4) Analyzing the stress distribution of composite beams by the FEM suggested that shear stress occurred mostly along the glue line between the flange and web near the central loading point.

5) The prediction of the critical span length at the failure mode transition agreed with the critical span length obtained by the experiments.

Properties of compressed laminated veneer lumber produced by steam pressing, S. KAWAI, Q. WANG, H. SASAKI, M. TANAHASHI and C. OHTA: *Mokuzai Gakkaishi*, **39**(5), 550–554 (1993).

Both resin-impregnated and untreated rotary-cut veneers of Japanese cedar (*Cryptomeria Japonica* D. Don) were pressed into thick, laminated veneer lumber (LVL) of different densities in a high steam-pressure vessel. The mechanical and physical properties of LVL were determined. The results were as follows: 1) 32–45 mm thick LVL could be manufactured under high pressure-steam with a pressing time of about seven minutes. 2) Both the moduli of rupture and elasticity of the LVL increased with increasing densities, and the values were much more than those of solid hardwood lumber of the same densities. 3) Both steam treatment and resin impregnation made great improvements in the dimensional stability of the compressed LVL. Less spring back after an accelerated aging test was

observed in LVL pressed at a high steam pressure level (10.2 kgf/cm²) than at a lower level (6.3 kgf/cm²). 4) Both isocyanate and phenolic resin adhesives were applicable in such a process of manufacturing LVL.

Isocyanate-inorganic bonded composites I. Tensile strength and scanning electron microscope observation of isocyanate-cement mixtures, D.A. EUSEBIO, Y. IMAMURA, S. KAWAI and H. SASAKI: *Mokuzai Gakkaishi*, **39**(1), 31-39 (1993).

The tensile strength of hardened cement as affected by the incorporation of isocyanate (IC) resin and the methods of IC-cement mixture application were determined. The microstructures of the resulting aggregates were observed under a scanning electron microscope (SEM). The optimum value of tensile strength was obtained when water-saturated adherends were used and bonded together by strewing the adherend surfaces with cement powder and subsequently spraying them with IC resin. SEM observations suggested that the hydration of cement could be achieved when water-saturated adherends were used, hence crystal formation was very remarkable. This crystallization process, however, was improved further with the incorporation of IC resin even at a very low level of addition. It also was revealed that the IC-cement network brought a large proportion of strength as the results of the interlocking and clustering effect of the cement complex and the anchoring of needle-like cement crystals to cell lumina. Increasing the pressure applied during the curing period favorably affected the tensile strength, but excess amounts of cement reduced the effect. Diminishing the amount of cement strewed per unit area of adherends bonded together, slightly improved tensile strength, but it cannot be ensured that the desirable properties of a board, such as exterior durability or fire resistance, would be obtained when this is adapted to board production.

Technology of high temperature/pressure steam treatment on wood, S. KAWAI: "Kawaru Mokuzai (Wood under developing)", p. 173-182, Kaisei-sha (1993) (in Japanese).

High temperature/pressure steam processing for composite wood and compressed products was reviewed. The feature of this technology was as follows; 1. Softening wood and fixing the compressive deformation. 2. supplying heat energy and accelerating the rapid cure of resin. Such features will give high dimensional stability of compressed wood or wood composition board which imply the internal stress under the pressing process. High pressure steam supplied the heat energy. As a result, it shortens the pressing time dramatically, therefore, this technology will make it possible to produce high performance composite wood products with large cross-section.

Energy consumption and environmental pollution in wood industry, S. KAWAI: Report of the 3rd research section in Japan Wood Research Society, Vol. 1, Research section of "Wood utilization and the protection of environment", p. 41-51 (1993) (in Japanese).

Abstract

In relation to the global environmental problems, energy consumption for producing various materials was discussed on the basis of the amount of released carbon dioxide and compared with each other, resulting that wood and its composites are harmonious materials with environment. Pollution problems and their countermeasures in wood industry were outlined.

Wood/Fiber composites, S. KAWAI: Report of the 3rd research section in Japan Wood Research Society, Vol. 2, Research section of "Wood composite materials", p. 54-60 (1993) (in Japanese).

Wood/fiber composites are classified. Glass fiber sheet reinforced composite wood such as glue-lam, laminated veneer lumber, particleboard and fiberboard are characterized. The properties and the production technology of wood fiber composites blended with a synthetic fiber were introduced.

Pacific rim bio-based composites symposium, S. KAWAI: *Zairyou* (J. Material Science of Jpn.), **42**(475), 464 (1993) (in Japanese).

The programs of the symposium held at Rotorua, New Zealand in 6-13 November, 1992 was outlined.

Participating in the pacific rim bio-based composite symposium in New Zealand, S. KAWAI: *APAST*, No. 7, 24-26 (1993) (in Japanese).

From the symposium held at Rotorua, New Zealand in 6-13 November, 1992, some interesting subjects were briefly described; these are research and development on fiber composites, steam-injection pressing, and the utilization and the recycling systems of non-wood cellulosic materials.

The present state and the subjects for future study in particleboard industry, S. KAWAI: *Mokkou Kikai* (Wood machinery), No. 158, 10-13 (in Japanese).

The present state of Japanese particleboard industry was briefly described with some statistical data on annual production. The properties of particleboard were compared with those of other wood based panels and characterized. The subjects for future study were pointed out; these are, particle-alignment technology for high rigidity and high dimensional stability of the board, steam-injection pressing for thick, low-density board, technology for the utilization of recycled raw-materials.

New processing technology for producing engineered wood, S. KAWAI: *Mokuzai Kogyo* (Wood Industry), **47**(11), 521-526 (1992) (in Japanese).

Recent progress of processing technology and the development of plant/equipment technology were briefly described. Especially, Research and development of orientation technology and pressing technology were explained.